

RESOURCE MANAGEMENT FOR CELL SWITCH

FIELDS

[1] Various example embodiments of the present disclosure generally relate to the field of telecommunication and in particular, to methods, apparatuses and computer readable storage medium for resource management for a cell switch.

BACKGROUND

[2] A Layer 1 or Layer 2 (L1/L2) triggered mobility (LTM) procedure is provided for handover of a terminal device (e.g., UE) from a source cell to a target cell. In the LTM procedure, a network device (e.g., gNB) receives L1 measurement report(s) from a UE, and on their basis the gNB changes UE serving cell by a cell switch command signalled via a Medium Access Control Control Element (MAC CE). The cell switch command indicates an LTM candidate configuration that the gNB previously prepared and provided to the UE through Radio Resource Control (RRC) signaling. Then the UE switches to the target configuration according to the cell switch command. The LTM procedure may be used to reduce the mobility latency.

SUMMARY

[3] In a first aspect of the present disclosure, there is provided an apparatus. The apparatus comprises at least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the apparatus at least to: receive a configuration indicating contention free random access (CFRA) resources for at least one candidate cell; receive a cell switch command indicating a target cell, the target cell being one of the at least one candidate cell; and discard the CFRA resources based on a Random Access Channel (RACH)-less cell switch to the target cell.

[4] In a second aspect of the present disclosure, there is provided a method. The method comprises: receiving a configuration indicating CFRA resources for at least one candidate cell; receiving a cell switch command indicating a target cell, the target cell being one of the at least one candidate cell; and discarding the CFRA resources based on a RACH-less cell switch to the target cell.

[5] In a third aspect of the present disclosure, there is provided an apparatus. The

apparatus comprises means for receiving a configuration indicating CFRA resources for at least one candidate cell; means for receiving a cell switch command indicating a target cell, the target cell being one of the at least one candidate cell; and means for discarding the CFRA resources based on a RACH-less cell switch to the target cell.

- 5 [6] In a fourth aspect of the present disclosure, there is provided a computer readable medium. The computer readable medium comprises instructions stored thereon for causing an apparatus to perform at least the method according to the second aspect.

- [7] It is to be understood that the Summary section is not intended to identify key or essential features of embodiments of the present disclosure, nor is it intended to be used
10 to limit the scope of the present disclosure. Other features of the present disclosure will become easily comprehensible through the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[8] Some example embodiments will now be described with reference to the accompanying drawings, where:

- 15 [9] FIG. 1 illustrates an example communication environment in which example embodiments of the present disclosure can be implemented;

[10] FIG. 2 illustrates a signaling flow for resource management for a cell switch;

[11] FIG. 3 illustrates an example of a LTM Cell Switch Command MAC CE;

- [12] FIG. 4 illustrates a flowchart of a method implemented at an apparatus according to
20 some example embodiments of the present disclosure;

[13] FIG. 5 illustrates a simplified block diagram of a device that is suitable for implementing example embodiments of the present disclosure; and

[14] FIG. 6 illustrates a block diagram of an example computer readable medium in accordance with some example embodiments of the present disclosure.

- 25 [15] Throughout the drawings, the same or similar reference numerals represent the same or similar element.

DETAILED DESCRIPTION

[16] Principle of the present disclosure will now be described with reference to some example embodiments. It is to be understood that these embodiments are described only

for the purpose of illustration and help those skilled in the art to understand and implement the present disclosure, without suggesting any limitation as to the scope of the disclosure. Embodiments described herein can be implemented in various manners other than the ones described below.

5 [17] In the following description and claims, unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skills in the art to which this disclosure belongs.

[18] References in the present disclosure to “one embodiment,” “an embodiment,” “an example embodiment,” and the like indicate that the embodiment described may include
10 a particular feature, structure, or characteristic, but it is not necessary that every embodiment includes the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature,
15 structure, or characteristic in connection with other embodiments whether or not explicitly described.

[19] It shall be understood that although the terms “first,” “second,” ..., etc. in front of noun(s) and the like may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element
20 from another and they do not limit the order of the noun(s). For example, a first element could be termed a second element, and similarly, a second element could be termed a first element, without departing from the scope of example embodiments. As used herein, the term “and/or” includes any and all combinations of one or more of the listed terms.

[20] As used herein, “at least one of the following: <a list of two or more elements>”
25 and “at least one of <a list of two or more elements>” and similar wording, where the list of two or more elements are joined by “and” or “or”, mean at least any one of the elements, or at least any two or more of the elements, or at least all the elements.

[21] As used herein, unless stated explicitly, performing a step “in response to A” does not indicate that the step is performed immediately after “A” occurs and one or more
30 intervening steps may be included.

[22] The terminology used herein is for the purpose of describing particular embodiments

only and is not intended to be limiting of example embodiments. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises”, “comprising”, “has”, “having”, “includes” and/or “including”, when used
5 herein, specify the presence of stated features, elements, and/or components etc., but do not preclude the presence or addition of one or more other features, elements, components and/ or combinations thereof.

[23] As used in this application, the term “circuitry” may refer to one or more or all of the following:

(a) hardware-only circuit implementations (such as implementations in only analog and/or digital circuitry) and

(b) combinations of hardware circuits and software, such as (as applicable):

(i) a combination of analog and/or digital hardware circuit(s) with software/firmware and

(ii) any portions of hardware processor(s) with software (including digital signal processor(s)), software, and memory(ies) that work together to cause an apparatus, such as a mobile phone or server, to perform various functions) and

(c) hardware circuit(s) and or processor(s), such as a microprocessor(s) or a portion of a microprocessor(s), that requires software (e.g., firmware) for operation, but the software may not be present when it is not needed for operation.

10 **[24]** This definition of circuitry applies to all uses of this term in this application, including in any claims. As a further example, as used in this application, the term circuitry also covers an implementation of merely a hardware circuit or processor (or multiple processors) or portion of a hardware circuit or processor and its (or their) accompanying software and/or firmware. The term circuitry also covers, for example and
15 if applicable to the particular claim element, a baseband integrated circuit or processor integrated circuit for a mobile device or a similar integrated circuit in server, a cellular network device, or other computing or network device.

[25] As used herein, the term “communication network” refers to a network following

any suitable communication standards, such as New Radio (NR), Long Term Evolution (LTE), LTE-Advanced (LTE-A), Wideband Code Division Multiple Access (WCDMA), High-Speed Packet Access (HSPA), Narrow Band Internet of Things (NB-IoT) and so on. Furthermore, the communications between a terminal device and a network device in the communication network may be performed according to any suitable generation communication protocols, including, but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the fifth generation (5G), the sixth generation (6G) communication protocols, and/or any other protocols either currently known or to be developed in the future. Embodiments of the present disclosure may be applied in various communication systems. Given the rapid development in communications, there will of course also be future type communication technologies and systems with which the present disclosure may be embodied. It should not be seen as limiting the scope of the present disclosure to only the aforementioned system.

[26] As used herein, the term “network device” refers to a node in a communication network via which a terminal device accesses the network and receives services therefrom. The network device may refer to a base station (BS) or an access point (AP), for example, a node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), an NR NB (also referred to as a gNB), a Remote Radio Unit (RRU), a radio header (RH), a remote radio head (RRH), a relay, an Integrated Access and Backhaul (IAB) node, a low power node such as a femto, a pico, a non-terrestrial network (NTN) or non-ground network device such as a satellite network device, a low earth orbit (LEO) satellite and a geosynchronous earth orbit (GEO) satellite, an aircraft network device, and so forth, depending on the applied terminology and technology. In some example embodiments, radio access network (RAN) split architecture comprises a Centralized Unit (CU) and a Distributed Unit (DU) at an IAB donor node. An IAB node comprises a Mobile Terminal (IAB-MT) part that behaves like a UE toward the parent node, and a DU part of an IAB node behaves like a base station toward the next-hop IAB node.

[27] The term “terminal device” refers to any end device that may be capable of wireless communication. By way of example rather than limitation, a terminal device may also be referred to as a communication device, user equipment (UE), a Subscriber Station (SS), a Portable Subscriber Station, a Mobile Station (MS), or an Access Terminal (AT). The terminal device may include, but not limited to, a mobile phone, a cellular phone, a smart

phone, voice over IP (VoIP) phones, wireless local loop phones, a tablet, a wearable terminal device, a personal digital assistant (PDA), portable computers, desktop computer, image capture terminal devices such as digital cameras, gaming terminal devices, music storage and playback appliances, vehicle-mounted wireless terminal devices, wireless endpoints, mobile stations, laptop-embedded equipment (LEE), laptop-mounted equipment (LME), USB dongles, smart devices, wireless customer-premises equipment (CPE), an Internet of Things (IoT) device, a watch or other wearable, a head-mounted display (HMD), a vehicle, a drone, a medical device and applications (e.g., remote surgery), an industrial device and applications (e.g., a robot and/or other wireless devices operating in an industrial and/or an automated processing chain contexts), a consumer electronics device, a device operating on commercial and/or industrial wireless networks, and the like. The terminal device may also correspond to a Mobile Termination (MT) part of an IAB node (e.g., a relay node). In the following description, the terms “terminal device”, “communication device”, “terminal”, “user equipment” and “UE” may be used interchangeably.

[28] As used herein, the term “resource,” “transmission resource,” “resource block,” “physical resource block” (PRB), “uplink resource,” or “downlink resource” may refer to any resource for performing a communication, for example, a communication between a terminal device and a network device, such as a resource in time domain, a resource in frequency domain, a resource in space domain, a resource in code domain, or any other combination of the time, frequency, space and/or code domain resource enabling a communication, and the like. In the following, unless explicitly stated, a resource in both frequency domain and time domain will be used as an example of a transmission resource for describing some example embodiments of the present disclosure. It is noted that example embodiments of the present disclosure are equally applicable to other resources in other domains.

[29] FIG. 1 illustrates an example communication environment 100 in which example embodiments of the present disclosure can be implemented. In the communication environment 100, a plurality of communication devices, including a first apparatus 110 and a second apparatus 120 can communicate with each other.

[30] In the example of FIG. 1, the second apparatus 120 has a certain coverage range, which may be called as a serving area or a source cell. The first apparatus 110 is located

in the cell managed by the second apparatus 120. In the communication environment 100, the second apparatus 120 may communicate data and control information with the first apparatus 110.

[31] In some example embodiments, if the first apparatus 110 is a terminal device and the second apparatus 120 is a network device, a link from the second apparatus 120 to the first apparatus 110 is referred to as a downlink (DL), while a link from the first apparatus 110 to the second apparatus 120 is referred to as an uplink (UL). In DL, the second apparatus 120 is a transmitting (TX) device (or a transmitter) and the first apparatus 110 is a receiving (RX) device (or a receiver). In UL, the first apparatus 110 is a TX device (or a transmitter) and the second apparatus 120 is a RX device (or a receiver).

[32] It is to be understood that the number of apparatuses and their connections shown in FIG. 1 are only for the purpose of illustration without suggesting any limitation. The communication environment 100 may include any suitable number of apparatuses configured to implementing example embodiments of the present disclosure.

[33] In the following, for purpose of illustration, some example embodiments are described with the first apparatus 110 operating as a terminal device and the second apparatus 120 operating as a network device. However, in some example embodiments, operations described in connection with a terminal device may be implemented at a network device or other device, and operations described in connection with a network device may be implemented at a terminal device or other device.

[34] Communications in the communication environment 100 may be implemented according to any proper communication protocol(s), comprising, but not limited to, cellular communication protocols of the first generation (1G), the second generation (2G), the third generation (3G), the fourth generation (4G), the fifth generation (5G), the sixth generation (6G), and the like, wireless local network communication protocols such as Institute for Electrical and Electronics Engineers (IEEE) 802.11 and the like, and/or any other protocols currently known or to be developed in the future. Moreover, the communication may utilize any proper wireless communication technology, comprising but not limited to: Code Division Multiple Access (CDMA), Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Frequency Division Duplex (FDD), Time Division Duplex (TDD), Multiple-Input Multiple-Output (MIMO), Orthogonal Frequency Division Multiple (OFDM), Discrete Fourier Transform spread

OFDM (DFT-s-OFDM) and/or any other technologies currently known or to be developed in the future.

[35] As discussed above, LTM is a procedure in which a network device, e.g., gNB, receives L1 measurement report(s) from a terminal device, e.g., UE, and on their basis the gNB changes UE serving cell by a cell switch command signalled via a MAC CE. The cell switch command indicates an LTM candidate configuration that the gNB previously prepared and provided to the UE through RRC signalling. Then the UE switches to the target configuration according to the cell switch command. The LTM procedure can be used to reduce the mobility latency.

[36] When configured by the network, it is possible to activate Transmission Configuration Indicator (TCI) states of one or multiple cells that are different from the current serving cell. For instance, the TCI states of the LTM candidate cells can be activated in advance before any of those cells become the serving cell. This allows the UE to be DL synchronized with those cells, thereby facilitating a faster cell switch to one of those cells when cell switch is triggered.

[37] When configured by the network, it is possible to initiate UL Timing Alignment (TA) acquisition (called early TA) procedure of one or multiple cells that are different from the current serving cells. If the cell has the same NTA as the current serving cells or NTA=0, early TA acquisition procedure is not required. The network may request the UE to perform early TA acquisition of a candidate cell before a cell switch. The early TA acquisition procedure is triggered by PDCCH order or realized through UE-based TA measurement as configured by RRC. In the former case, the gNB to which the candidate cell belongs calculates the TA value and sends it to the gNB to which the serving cell belongs. The serving cell sends the TA value in the LTM cell switch command MAC CE when triggering LTM cell switch. In the latter case, the UE performs TA measurement for the candidate cells after being configured by RRC but the exact time the UE performs TA measurement is up to UE implementation. The UE applies the TA value measured by itself and performs Random Access Channel (RACH)-less LTM upon receiving the cell switch command. The network may also send a TA value in the LTM cell switch command MAC CE without early TA acquisition.

[38] Depending on the availability of a valid TA value, the UE performs either a RACH-less LTM or RACH-based LTM cell switch. If the TA value is provided in the cell switch

command, the UE applies the TA value as instructed by the network. In the case where UE-based TA measurement is configured, but no TA value is provided in the cell switch command, the UE applies the TA value by itself if available. Meanwhile, the UE performs RACH-less LTM cell switch upon receiving the cell switch command. If no valid TA value is available, the UE performs RACH-based LTM cell switch.

[39] Regardless of whether the UE is configured for UE-based TA measurement for a certain candidate cell, it will still follow the PDCCH order, which includes requesting a random access procedure towards the candidate cells. This also applies to the candidate cells for which the UE is capable of deriving TA values by itself. Additionally, regardless of whether the UE has already performed a random access procedure towards the candidate cells, it will still follow the UE-based measurement configuration if configured by the network.

[40] For RACH-less LTM, the UE accesses the target cell using either a configured grant or a dynamic grant. The configured grant is provided in the LTM candidate configuration, and the UE selects the configured grant occasion associated with the beam indicated in the cell switch command. Upon initiation of LTM cell switch to the target cell, the UE starts to monitor Physical Downlink Control Channel (PDCCH) on the target cell for dynamic scheduling. Before RACH-less LTM procedure completion, the UE shall not trigger random access procedure if it does not have a valid Physical Uplink Control Channel (PUCCH) resource for triggered SRs.

[41] The following principles apply to LTM, one is that security key is maintained upon an LTM cell switch, and the other one is that subsequent LTM is supported.

[42] LTM supports both intra-gNB-DU and intra-gNB-CU inter-gNB-DU mobility. LTM supports both intra-frequency and inter-frequency mobility, including mobility to inter-frequency cell that is not a current serving cell. LTM is supported only for licensed spectrum. The following scenarios are supported:

- PCell change in non-CA scenario and non-DC scenario;
- Pcell and Scell(s) change in CA scenario;
- Dual connectivity scenario, Pcell and MCG Scell(s) change and intra-SN PSCell and SCG Scell(s) change without MN involvement. LTM for simultaneous Pcell and PSCell change is not supported.

[43] While the UE has stored LTM candidate configurations the UE can also execute any L3 handover command sent by the network.

[44] RRC provided CFRA resources may be pre-provisioned to the UE for any LTM candidate in the ltm-Config (R2-2313672), (TS 38.331 v18.0.0). Table 1 shows an
5 example of a part of the LTM configuration.

Table 1

– *LTM-CandidateId*

The IE *LTM-CandidateId* is used to identify an LTM candidate configuration.

***LTM-CandidateId* information element**

-- ASN1START

-- TAG-LTM-CANDIDATEID-START

LTM-CandidateId-r18 ::= INTEGER (1..maxNrofLTM-Configs-r18)

-- TAG-LTM-CANDIDATEID-STOP

-- ASN1STOP

– *LTM-Candidate*

The IE *LTM-Candidate* concerns a LTM candidate configuration to add or modify.

***LTM-Candidate* information element**

-- ASN1START

-- TAG-LTM-CANDIDATE-START

LTM-Candidate-r18 ::= SEQUENCE {
 ltm-CandidateId-r18 LTM-CandidateId-r18,
 ltm-CandidatePCI-r18 PhysCellId,
 ltm-SSB-Config-r18 LTM-SSB-Config-r18 OPTIONAL, --
 Need M
 ltm-CandidateConfig-r18 OCTET STRING (CONTAINING RRCReconfiguration)
 OPTIONAL, -- Need M
 ltm-ConfigComplete-r18 ENUMERATED {true} OPTIONAL,
 -- Need R
 ltm-EarlyUL-SyncConfig-r18 SetupRelease { EarlyUL-SyncConfig-r18 }
 OPTIONAL, -- Need M
 ltm-EarlyUL-SyncConfigSUL-r18 SetupRelease { EarlyUL-SyncConfig-r18 }
 OPTIONAL, -- Need M
 ltm-NoResetID-r18 INTEGER (1..maxNrofLTM-Configs-r18-plus-1)
 OPTIONAL, -- Need M
 ltm-DL-OrJointTCI-StateToAddModList-r18 SEQUENCE (SIZE (1..maxNrofCandidateTCI-
 State-r18)) OF CandidateTCI-State-r18
 OPTIONAL, -- Need N
 ltm-DL-OrJointTCI-StateToReleaseList-r18 SEQUENCE (SIZE (1..maxNrofCandidateTCI-State-
 r18)) OF TCI-StateId

	OPTIONAL, -- Need N
ltm-UL-TCI-StatesToAddModList-r18	SEQUENCE (SIZE (1..maxNrofCandidateUL-TCI-r18)) OF CandidateTCI-UL-State-r18
	OPTIONAL, -- Need N
ltm-UL-TCI-StatesToReleaseList-r18	SEQUENCE (SIZE (1..maxNrofCandidateUL-TCI-r18)) OF TCI-UL-StateId-r17
	OPTIONAL, -- Need N
ltm-nzp-CSI-RS-ResourceToAddModList-r18	SEQUENCE (SIZE (1..maxNrofNZP-CSI-RS-Resources)) OF NZP-CSI-RS-Resource
	OPTIONAL, -- Need N
ltm-nzp-CSI-RS-ResourceToReleaseList-r18	SEQUENCE (SIZE (1..maxNrofNZP-CSI-RS-Resources)) OF NZP-CSI-RS-ResourceId
	OPTIONAL, -- Need N
ltm-nzp-CSI-RS-ResourceSetToAddModList-r18	SEQUENCE (SIZE (1..maxNrofNZP-CSI-RS-ResourceSets)) OF NZP-CSI-RS-ResourceSet
	OPTIONAL, -- Need N
ltm-nzp-CSI-RS-ResourceSetToReleaseList-r18	SEQUENCE (SIZE (1..maxNrofNZP-CSI-RS-ResourceSets)) OF NZP-CSI-RS-ResourceSetId
	OPTIONAL, -- Need N
pathlossReferenceRS-ToAddModList-r18	SEQUENCE (SIZE (1..maxNrofPathlossReferenceRSs-r17)) OF PathlossReferenceRS-r17
	OPTIONAL, -- Need N
pathlossReferenceRS-ToReleaseList-r18	SEQUENCE (SIZE (1..maxNrofPathlossReferenceRSs-r17)) OF PathlossReferenceRS-Id-r17
	OPTIONAL, -- Need N
ltm-UE-MeasuredTA-ID-r18	INTEGER (1..maxNrofLTM-Configs-r18-plus-1)
OPTIONAL, -- Need M	
...	
}	
LTM-SSB-Config-r18 ::= SEQUENCE {	
ssbFrequency-r18	ARFCN-ValueNR,
subCarrierSpacing-r18	SubCarrierSpacing,
ssb-Periodicity-r18	ENUMERATED {ms5, ms10, ms20, ms40, ms80, ms160, spare2, spare1}
OPTIONAL, -- Need R	
ssb-PositionsInBurst-r18	CHOICE {
shortBitmap	BIT STRING (SIZE (4)),
mediumBitmap	BIT STRING (SIZE (8)),

```

    longBitmap                BIT STRING (SIZE (64))
    }                          OPTIONAL, -- Need R
    ss-PBCH-BlockPower-r18     INTEGER (-60..50)
OPTIONAL, -- Need R
    ...
}

-- TAG-LTM-CANDIDATE-STOP
-- ASN1STOP

```

– *LTM-Config*

The IE *LTM-Config* is used to provide LTM candidate configurations.

***LTM-Config* information element**

```

-- ASN1START
-- TAG-LTM-CONFIG-START

LTM-Config-r18 ::= SEQUENCE {
    ltm-ReferenceConfiguration-r18    SetupRelease {ReferenceConfiguration-r18}
OPTIONAL, -- Need M
    ltm-CandidateToReleaseList-r18    SEQUENCE (SIZE (1..maxNrofLTM-Configs-r18)) OF LTM-
CandidateId-r18    OPTIONAL, -- Need N
    ltm-CandidateToAddModList-r18     SEQUENCE (SIZE (1..maxNrofLTM-Configs-r18)) OF
LTM-Candidate-r18    OPTIONAL, -- Need N
    ltm-ServingCellNoResetID-r18      INTEGER (1..maxNrofLTM-Configs-r18-plus-1)
OPTIONAL, -- Cond FirstLTM-Only
    ltm-CSI-ResourceConfigToAddModList-r18    SEQUENCE (SIZE (1..maxNrofLTM-CSI-
ResourceConfigurations-r18)) OF LTM-CSI-ResourceConfig-r18
                                                    OPTIONAL, -- Need N
    ltm-CSI-ResourceConfigToReleaseList-r18    SEQUENCE (SIZE (1..maxNrofLTM-CSI-
ResourceConfigurations-r18)) OF LTM-CSI-ResourceConfigId-r18
                                                    OPTIONAL, -- Need N
    attemptLTM-Switch-r18             ENUMERATED {true}
OPTIONAL, -- Cond LTM-MCG
    ltm-ServingCellUE-MeasuredTA-ID-r18    INTEGER (1..maxNrofLTM-Configs-r18-plus-1)
OPTIONAL, -- Cond LTM
    ...
}

-- TAG-LTM-CONFIG-STOP

```

-- ASN1STOP

[45] The *RRCReconfiguration* above includes the *ReconfigurationWithSync* information element (IE) for LTM. Table 2 shows an example of the RRC reconfiguration.

Table 2

5.3.5 RRC reconfiguration

5.3.5.1 General

RRC reconfiguration to perform reconfiguration with sync includes, but is not limited to, the following cases:

- reconfiguration with sync for LTM cell switch (without security key refresh), and
 - involving or not involving RA to the target LTM candidate SpCell according to a network indication;
 - MAC reset;
 - depending on a network indication, re-establishment of RLC and PDCP data recovery (for AM DRB).
- reconfiguration with sync for LTM cell switch (without security key refresh), and
 - involving or not involving RA to the target LTM candidate SpCell according to a network indication;
 - MAC reset;
 - depending on a network indication, no re-establishment of RLC.

– *CellGroupConfig*

The *CellGroupConfig* IE is used to configure a master cell group (MCG) or secondary cell group (SCG). A cell group comprises of one MAC entity, a set of logical channels with associated RLC entities and of a primary cell (SpCell) and one or more secondary cells (SCells).

***CellGroupConfig* information element**

ReconfigurationWithSync ::=	SEQUENCE {	
spCellConfigCommon	ServingCellConfigCommon	OPTIONAL, --
Need M		
newUE-Identity	RNTI-Value,	
t304	ENUMERATED {ms50, ms100, ms150, ms200, ms500, ms1000, ms2000,	
ms10000},		
rach-ConfigDedicated	CHOICE {	
uplink	RACH-ConfigDedicated,	
supplementaryUplink	RACH-ConfigDedicated	
}	OPTIONAL, -- Need N	

[46] Currently, the CFRA resources provided for handover (ReconfigurationWithSync) are released upon the RA procedure completion towards the target cell (TS 38.321 v17.6.0).

[47] Upon completion of the Random Access procedure, the MAC entity may discard any explicitly signalled contention-free Random Access Resources for 2-step RA type and 4-step RA type except the 4-step RA type contention-free Random Access Resources for beam failure recovery request, if any; flush the HARQ buffer used for transmission of the
5 MAC PDU in the Msg3 buffer and the MSGA buffer. Upon successful completion of the Random Access procedure initiated for DAPS handover, the target MAC entity shall indicate the successful completion of the Random Access procedure to the upper layers.

[48] By means of this, the UE can use the CFRA resources only for the RA procedure involved for the handover and after that, the CFRA resources are discarded so that NW
10 can reuse them for some other UE.

[49] In some cases, when the network (NW) triggers LTM cell switch with the LTM Cell Switch Command (CSC) MAC CE and indicates UE to apply indicated TAC (Timing Advance Command) or the UE estimated TA, RACH-less LTM cell switch is performed by the UE. In this case, the UE enters a target cell and starts to decode PDCCH for any
15 dynamic DL assignments or UL grants. At the same time, if the UE has been pre-configured with Configured Grant (CG) resources, the UE may transmit on the CG to complete the LTM cell switch.

[50] Contention-Based Random Access (CBRA) resources and/or Contention-Free Random Access (CFRA) resources may be configured in the LTM cell switch. CBRA is
20 an initial step when a terminal device wants to establish communication with the network or during handover procedures. When a UE needs to perform an RRC connection establishment or re-establishment, it uses a random access procedure where multiple UEs might simultaneously attempt to send their preambles on a shared PRACH (Physical Random Access Channel). This is a contention-based process because if more than one
25 UE sends at the same time, collisions occur, and those UEs have to retry after a backoff period. The resources used for such contention-based process may be referred to as CBRA resources.

[51] The CFRA resources may be the resource allocated for a UE by the network for data transmission or signaling purposes after the initial contention-based random access phase.
30 For instance, during a handover, once the target cell acknowledges the UE's presence and assigns dedicated resources, further communications may be performed using the dedicated resources.

[52] When a RACH-less cell switch is triggered, the UE may not perform a Random Access (RA) procedure towards the target cell and the CFRA resources pre-provisioned or preconfigured to the UE remain in the UE configuration. Hence, when RA procedure is next time triggered (e.g., Scheduling Request (SR), SR failure, beam failure recovery (BFR), UL timing alignment acquisition), UE applies the CFRA resources in the RA procedure, which may be problematic and unexpected by the NW. This is because the CFRA resources were pre-provisioned for the purpose of LTM cell switch in case RACH-less could not be used.

[53] To solve the above and/or other potential issues, example embodiments of the present disclosure propose a solution to enable a terminal device (e.g., UE) to discard the CFRA resources of the target cell upon a RACH-less cell switch. In the solution, the terminal device first receives a configuration indicating CFRA resources for at least one candidate cell, and also receives a cell switch command indicating a target cell which is one of the at least one candidate cell. Based on a Random Access Channel (RACH)-less cell switch to the target cell, the terminal device discards the CFRA resources. As such, the NW can reuse the CFRA resources configured for a terminal device performing RACH-less cell switch immediately to another terminal device.

[54] Example embodiments of the present disclosure will be described in detail below with reference to the accompanying drawings.

[55] FIG. 2 illustrates a signaling flow 200 for resource management for a cell switch. For the purposes of discussion, the signaling flow 200 will be discussed with reference to FIG. 1, for example, by using the first apparatus 110 and the second apparatus 120.

[56] In the signaling flow 200, the second apparatus 120 transmits (205) a configuration indicating CFRA resources for one or more candidate cells. The candidate cell(s) may act as candidates for a cell switch or a handover process. In some embodiments, the cell switch may be a LTM cell switch. In such cases, the candidate cell(s) may be used for the LTM cell switch. In the case where the cell switch is a LTM cell switch, the configuration received by the first apparatus 110 may be a LTM configuration.

[57] The first apparatus 110 receives (210) the configuration from the second apparatus 120. Thus, the first apparatus 110 has the knowledge of the CFRA resources for the one or more candidate cells. The CFRA resources may be 2-step RA resources or 4-step RA resources. That is, the CFRA resources may be allocated for a RA procedure of 2-step RA

type or 4-step RA type.

[58] In some example embodiments, the second apparatus 120 transmits (215) a cell switch command indicating a target cell to the first apparatus 110. The target cell is one of the at least one candidate cell for the cell switch. In some example embodiments, the first apparatus 110 may determine the target cell based on a target configuration index in the cell switch command. Thus, upon receiving (220) the cell switch command, the first apparatus 110 will be aware of the target cell for the upcoming cell switch.

[59] An example implementation of the LTM Cell Switch Command will be discussed below in Table 3 by taking the third generation partnership project (3GPP) TS 38.321 v18.0.0 as an example.

Table 3

5.18.xy LTM Cell Switch Command The network may instruct the UE to perform LTM cell switch procedure by sending the LTM Cell Switch Command MAC CE described in clause 6.1.3.xy. The MAC entity shall: 1> if the MAC entity receives an LTM Cell Switch Command MAC CE on a Serving Cell: 2> indicate to upper layers that the LTM cell switch procedure is triggered and the Target Configuration ID included in the MAC CE; 2> if the MAC reset operation as specified in sub-clause 5.12 is performed, as requested by upper layers: 3> if Timing Advance Command value (hexa-decimal) is not set as FFF: 4> process the received Timing Advance Command (see clause 5.2); 4> consider the RACH-less LTM cell switch to be ongoing; 4> if the MAC entity is associated with SCG: 5> indicate to upper layers to skip the Random Access procedure for this LTM cell switch. 3> else if the Timing Advance measurement is configured as specified in TS 38.331 [5] and the UE has successfully measured the Timing Advance for the indicated LTM target: 4> process the measured Timing Advance (see clause 5.2); 4> consider the RACH-less LTM cell switch to be ongoing. 4> if the MAC entity is associated with SCG: 5> indicate to upper layers to skip the Random Access procedure for this

LTM cell switch.

- 3> if TCI state information is included:
 - 4> consider the SSB corresponding to the indicated TCI state as the one used for configured uplink grant selection for the initial uplink transmission towards the candidate cell for RACH-less LTM cell switch (as in clause 5.8.2);
 - 4> indicate to lower layers the information regarding the TCI state information included in the LTM Cell Switch Command MAC CE.

[60] An example implementation of the LTM Cell Switch Command MAC CE will be discussed below in Table 4 by taking 3GPP TS 38.321 v18.0.0 as an example.

Table 4

6.1.3.xy LTM Cell Switch Command MAC CE

The LTM Cell Switch Command MAC CE is identified by MAC subheader with eLCID as specified in Table 6.2.1-1b. It has a variable size with following fields (Figure 6.1.3.xy-1):

- R: Reserved bit, set to 0;
- Target Configuration ID: This field indicates the index of candidate target configuration to apply for LTM cell switch, corresponding to *ltm-CandidateId* minus 1 as specified in TS 38.331 [5]. The length of the field is 3 bits;
- Timing Advance Command: This field indicates whether the TA is valid for the LTM target cell (i.e. the SpCell corresponding to the target configuration indicated by Target Configuration ID field). If the value of this field is set to FFF, this field indicates that no valid timing adjustment is available for the PTAG of the LTM target cell; Otherwise, this field indicates the index value T_A used to control the amount of timing adjustment that the MAC entity has to apply in TS 38.213 [6], and that the UE can skip the Random Access procedure for this LTM cell switch. The length of the field is 12 bits;
- TCI state ID: This field indicates and activates the TCI state for the LTM target cell (i.e. the SpCell of the target configuration indicated by the Target Configuration ID field). The TCI state is identified by *TCI-StateId* in *ltm-DL-Or-JointTCI-StateToAddModList* as specified in TS 38.331 [5]. If the value of *unifiedTCI-StateType* in the configuration indicated by Target Configuration ID field is *joint*, this field is for joint TCI state, otherwise, this field is for downlink TCI state. The length

of the field is 7 bits;

- UL TCI state ID: This field indicates and activates the uplink TCI state for the LTM target cell (i.e. the SpCell of the target configuration indicated by the Target Configuration ID field). The most significant bits of UL TCI state ID are considered as reserved bits and the remainder 6 bits indicate the *TCI-UL-StateId* in *lrm-UL-TCI-StatesToAddModList* as specified in TS 38.331 [5]. This field is included if the value of *unifiedTCI-StateType* in the configuration indicated by Target Configuration ID field is *separate*. The length of the field is 8 bits;
- C: This field indicates the presence of the contention-free Random Access Resources fields. If the value of this field is set to 1, the following fields are present, including Random Access Preamble index field, S/U field, SS/PBCH index field and PRACH Mask index field. If the value of this field is set to 0, Random Access Preamble index field, SS/PBCH index field and PRACH Mask index field are absent, and S/U field is considered as Reserved field.
- S/U: This field indicates which UL carrier to transmit the PRACH of the contention-free Random Access Resources. If the value of this field is set to 1, SUL is used; otherwise, NUL is used. The length of the field is 1 bit;
- Random Access Preamble index: This field indicates the Random Access Preamble index of the contention-free Random Access Resources. The length of the field is 6 bits;
- SS/PBCH index: This field indicates the SS/PBCH that shall be used to determine the RACH occasion for the PRACH transmission of the contention-free Random Access Resources. The length of the field is 6 bits;
- PRACH Mask index: This field indicates the RACH occasion(s) associated with the SS/PBCH indicated by "SS/PBCH index" for the PRACH transmission of the contention-free Random Access Resources, referring to the *rach-ConfigDedicated* (if not provided otherwise to the *rach-ConfigCommon*) in the UL BWP configuration of *firstActiveUplinkBWP-Id* as specified in TS 38.331 [5]. The length of the field is 4 bits;

[61] FIG. 3 corresponds to the Figure 6.1.3.xy-1 discussed in Table 4. FIG. 3 illustrates an example of a LTM Cell Switch Command MAC CE. The content in the LTM Cell Switch Command MAC CE has been discussed with reference to Table 4 as discussed above.

[62] Still referring to FIG. 2, the first apparatus 110 discards (225) the CFRA resources based on a RACH-less cell switch to the target cell. As used herein, the term “discard” may refer to a release of the CFRA resources, or retaining the CFRA resources but not using them anything else but RA procedure for a cell switch.

5 [63] In some example embodiments, the RACH-less cell switch is an LTM cell switch. For example, the first apparatus 110 discards (225) the CFRA resources in response to that a RACH-less LTM cell switch to the target cell is to be performed.

[64] Specifically, in some implementations where the first apparatus 110 is a terminal device, e.g., a UE, the UE may discard any explicitly signalled (e.g. RRC configured)
10 CFRA resources upon RACH-less LTM cell switch is triggered by the LTM CSC MAC CE. These CFRA resources may be either 4-step RA or 2-step RA type resources.

[65] The CFRA resources may be discarded in various ways. In some example embodiments, the CFRA resources associated with the target cell may be discarded. Alternatively, the CFRA resources associated with all of the at least one candidate cell
15 may be discarded. Alternatively, the CFRA resources associated with a set of cells of the at least one candidate cell may be discarded.

[66] In some example embodiments, the CFRA resources may be discarded based on a TAC (e.g. the field provisioning the Timing Advance, TA, information). The first apparatus 110 may obtain the TAC, for example, from the cell switch command received
20 (220) from the second apparatus 120. If a value in the TAC is not set to a predetermined value, the first apparatus 110 may discard the CFRA resources. On the other hand, if the value in the TAC is not set to a predetermined value, the first apparatus 110 may measure a value of Timing Advance (TA) for the target cell. If the value of the TA is successfully measured, the first apparatus 110 may discard the CFRA resources. TA measurement may
25 refer to a UE based TA measurement.

[67] The predetermined value may be, for example, a hexadecimal value of FFF. It is to be understood that this is just an example of the predetermined value for the TAC, rather than suggesting any limitation. Other suitable values may be applicable to further embodiments of the present disclosure.

30 [68] In an example, the CFRA resources may be discarded in case a Timing Advance Command (TAC) (fields/octets providing the TAC information) is provided in the LTM

CSC MAC CE or if the TAC field is not set to FFF (hexadecimal value).

[69] In one example, the CFRA resources may be discarded in case the TAC is provided, its value is set to FFF and the UE has successfully measured TA for the indicated LTM target cell. The indicated LTM target cell may be determined based on the Target
5 Configuration Index as provided by the LTM CSC MAC CE.

[70] In some example embodiments, the CFRA resources may be discarded at different time points. In an implementation, the CFRA resources may be discarded at a time point that the RACH-less cell switch is completed. For example, when at least one RRC message completing the RACH-less cell switch is transmitted, it may be determined that the
10 RACH-less cell switch is completed. In this case, the CFRA resources may be discarded at the time point that the at least one RRC message completing the RACH-less cell switch is transmitted. In an implementation, the CFRA resources may be discarded at a time point that the cell switch command triggering RACH-less cell switch is received. In an implementation, the CFRA resources may be discarded at a time point that the message
15 provisioning the cell switch command (triggering RACH-less cell switch) is acknowledged. In an implementation, the CFRA resources may be discarded at a time point when the RACH-less cell switch is initiated/started.

[71] Alternatively, the first apparatus 110 may discard the CFRA resources at a time point that the first apparatus 110 performs at least one uplink transmission on the target
20 cell to which the apparatus is switched.

[72] Specifically, in one example, the CFRA resources may be discarded upon RACH-less LTM cell switch is completed. In another example, the cell switch is completed once the UE has successfully provisioned at least one RRC message completing the LTM cell switch.

25 [73] Alternatively, in one example, the CFRA resources may be discarded upon the UE performing at least one uplink transmission on the LTM target cell for which the UE is switched to (e.g. using configured grant or PDCCH scheduled UL grant).

[74] In some example embodiments, the CFRA resources may be discarded via a MAC layer or a RRC layer. In one example, the MAC layer may indicate to the RRC layer to
30 discard the CFRA resources.

[75] In some example embodiments, the discarded CFRA resources exclude CFRA

resources for beam failure recovery. For example, the first apparatus 110 may be a terminal device, e.g., a UE, and the UE does not discard BFR CFRA resources configured for the target cell, if any.

[76] In some example embodiments, the discarding of the CFRA resources may be configured in advance (or predefined in advance e.g. in specification). In some implementations, the first apparatus 110 may receive a further configuration indicating whether the CFRA resources are to be discarded. The further configuration may include other information about the discarding. For instance, the further configuration may indicate that the CFRA resources are discarded per cell. Alternatively, the further configuration may indicate that the CFRA resources are discarded per set of cells. As a further alternative, the further configuration may indicate that the CFRA resources are discarded for the at least one candidate cell.

[77] In an example, whether the CFRA resources are discarded or not may be configured by a RRC signaling. The discarding may be configured per cell or, per set of cells or for the cells included in the LTM configuration.

[78] Some example implementation options into TS 38.321 for example embodiments of the present disclosure are provided in the following Table 5.

Table 5

5.18.xy LTM Cell Switch Command

The network may instruct the UE to perform LTM cell switch procedure by sending the LTM Cell Switch Command MAC CE described in clause 6.1.3.xy.

The MAC entity shall:

- 1> if the MAC entity receives an LTM Cell Switch Command MAC CE on a Serving Cell:
 - 2> indicate to upper layers that the LTM cell switch procedure is triggered and the Target Configuration ID included in the MAC CE;
 - 2> if the MAC reset operation as specified in sub-clause 5.12 is performed, as requested by upper layers:
 - 3> if Timing Advance Command value (hexa-decimal) is not set as FFF:
 - 4> process the received Timing Advance Command (see clause 5.2);
 - 4> consider the RACH-less LTM cell switch to be ongoing;
 - 4> **discard any explicitly signalled contention-free Random Access Resources for 2-step RA type and 4-step RA type except the 4-step RA type contention-free Random Access Resources for beam failure recovery request, if any, for the LTM target cell as indicated by the Target Configuration ID;**
 - 4> if the MAC entity is associated with SCG:
 - 5> indicate to upper layers to skip the Random Access procedure for this LTM cell switch.
 - 3> else if the Timing Advance measurement is configured as specified in TS 38.331 [5] and the UE has successfully measured the Timing Advance for the indicated LTM target:
 - 4> process the measured Timing Advance (see clause 5.2);
 - 4> consider the RACH-less LTM cell switch to be ongoing;
 - 4> **discard any explicitly signalled contention-free Random Access Resources for 2-step RA type and 4-step RA type except the 4-step RA type contention-free Random Access Resources for beam failure recovery request, if any, for the LTM target cell as indicated by the Target Configuration ID;**
 - 4> if the MAC entity is associated with SCG:
 - 5> indicate to upper layers to skip the Random Access procedure for this LTM cell switch.
 - 3> if TCI state information is included:
 - 4> consider the SSB corresponding to the indicated TCI state as the one used for configured uplink grant selection for the initial uplink transmission towards the candidate cell for RACH-less LTM cell switch (as in clause 5.8.2);
- 4> indicate to lower layers the information regarding the TCI state information included in the LTM Cell Switch Command MAC CE.

[79] In view of the above, the NW can reuse the CFRA resources configured for a UE performing RACH-less LTM cell switch immediately to another UE.

[80] FIG. 4 shows a flowchart of an example method 400 implemented at an apparatus in accordance with some example embodiments of the present disclosure. For the purpose
5 of discussion, the method 400 will be described from the perspective of the first apparatus 110 in FIG. 1.

[81] At block 410, the first apparatus 110 receives a configuration indicating CFRA resources for at least one candidate cell.

[82] At block 420, the first apparatus 110 receives a cell switch command indicating a
10 target cell, the target cell being one of the at least one candidate cell.

[83] At block 430, the first apparatus 110 discards the CFRA resources based on a RACH-less cell switch to the target cell.

[84] In some example embodiments, the method 400 further comprises: determining the target cell based on a target configuration index in the cell switch command.

15 [85] In some example embodiments, the CFRA resources are 4-step Random Access (RA) resources or 2-step RA resources.

[86] In some example embodiments, the method 400 further comprises: discarding the CFRA resources associated with the target cell, or discarding the CFRA resources associated with all of the at least one candidate cell, or discarding the CFRA resources
20 associated with a set of cells of the at least one candidate cell.

[87] In some example embodiments, the method 400 further comprises: obtaining a Timing Advance Command (TAC) from the cell switch command; and discarding the CFRA resources based on the TAC.

[88] In some example embodiments, the method 400 further comprises: in accordance
25 with a determination that a value in the TAC is not set to a predetermined value, discarding the CFRA resources.

[89] In some example embodiments, the method 400 further comprises: in accordance with a determination that a value in the TAC is not set to a predetermined value, measuring a value of Timing Advance (TA) for the target cell; and in accordance with a
30 determination that the value of the TA is successfully measured, discarding the CFRA

resources.

[90] In some example embodiments, the predetermined value is a hexadecimal value of FFF.

5 [91] In some example embodiments, the method 400 further comprises: discarding the CFRA resources at a time point that the RACH-less cell switch is completed.

[92] In some example embodiments, the method 400 further comprises: discarding the CFRA resources at a time point that at least one Radio Resource Control (RRC) message completing the RACH-less cell switch is transmitted.

10 [93] In some example embodiments, the method 400 further comprises: discarding the CFRA resources at a time point that the apparatus performs at least one uplink transmission on the target cell to which the apparatus is switched.

[94] In some example embodiments, the method 400 further comprises: receiving a further configuration indicating whether the CFRA resources are to be discarded.

15 [95] In some example embodiments, the further configuration further indicates that the CFRA resources are discarded per cell, per set of cells, or for the at least one candidate cell.

[96] In some example embodiments, the CFRA resources are discarded via a Medium Access Control (MAC) layer or a Radio Resource Control (RRC) layer.

20 [97] In some example embodiments, the discarded CFRA resources exclude CFRA resources for beam failure recovery.

[98] In some example embodiments, the at least one candidate cell is for a Layer 1 or Layer 2 (L1/L2) triggered mobility (LTM) cell switch.

[99] In some example embodiments, the RACH-less cell switch is a RACH-less Layer 1 or Layer 2 (L1/L2) triggered mobility (LTM) cell switch.

25 [100] In some example embodiments, an apparatus capable of performing any of the method 400 (for example, the first apparatus 110 in FIG. 1) may comprise means for performing the respective operations of the method 400. The means may be implemented in any suitable form. For example, the means may be implemented in a circuitry or software module. The apparatus may be implemented as or included in the first apparatus

110 in FIG. 1.

[101] In some example embodiments, the apparatus comprises means for receiving a configuration indicating contention free random access (CFRA) resources for at least one candidate cell; means for receiving a cell switch command indicating a target cell, the
5 target cell being one of the at least one candidate cell; and means for discarding the CFRA resources based on a Random Access Channel (RACH)-less cell switch to the target cell.

[102] In some example embodiments, the apparatus further comprises: means for determining the target cell based on a target configuration index in the cell switch command.

10 [103] In some example embodiments, the CFRA resources are 4-step Random Access (RA) resources or 2-step RA resources.

[104] In some example embodiments, the apparatus further comprises: means for discarding the CFRA resources associated with the target cell, or means for discarding the CFRA resources associated with all of the at least one candidate cell, or means for
15 discarding the CFRA resources associated with a set of cells of the at least one candidate cell.

[105] In some example embodiments, the apparatus further comprises: means for obtaining a Timing Advance Command (TAC) from the cell switch command; and means for discarding the CFRA resources based on the TAC.

20 [106] In some example embodiments, the apparatus further comprises: means for in accordance with a determination that a value in the TAC is not set to a predetermined value, discarding the CFRA resources.

[107] In some example embodiments, the apparatus further comprises: means for in accordance with a determination that a value in the TAC is not set to a predetermined
25 value, measuring a value of Timing Advance (TA) for the target cell; and means for in accordance with a determination that the value of the TA is successfully measured, discarding the CFRA resources.

[108] In some example embodiments, the predetermined value is a hexadecimal value of FFF.

30 [109] In some example embodiments, the apparatus further comprises: means for

discarding the CFRA resources at a time point that the RACH-less cell switch is completed.

[110] In some example embodiments, the apparatus further comprises: means for discarding the CFRA resources at a time point that at least one Radio Resource Control (RRC) message completing the RACH-less cell switch is transmitted.

5 [111] In some example embodiments, the apparatus further comprises: means for discarding the CFRA resources at a time point that the apparatus performs at least one uplink transmission on the target cell to which the apparatus is switched.

[112] In some example embodiments, the apparatus further comprises: means for receiving a further configuration indicating whether the CFRA resources are to be
10 discarded.

[113] In some example embodiments, the further configuration may further indicate that the CFRA resources are discarded per cell, per set of cells, or for the at least one candidate cell.

[114] In some example embodiments, the CFRA resources are discarded via a MAC layer
15 or a RRC layer.

[115] In some example embodiments, the discarded CFRA resources exclude CFRA resources for beam failure recovery.

[116] In some example embodiments, the at least one candidate cell is for a LTM cell switch.

20 [117] In some example embodiments, the RACH-less cell switch is a RACH-less LTM cell switch.

[118] In some example embodiments, the first apparatus further comprises means for performing other operations in some example embodiments of the method 400 or the first apparatus 110. In some example embodiments, the means comprises at least one processor;
25 and at least one memory storing instructions that, when executed by the at least one processor, cause the performance of the first apparatus.

[119] FIG. 5 is a simplified block diagram of a device 500 that is suitable for implementing example embodiments of the present disclosure. The device 500 may be provided to implement a communication device, for example, the first apparatus 110 or the second
30 apparatus 120 as shown in FIG. 1. As shown, the device 500 includes one or more

processors 510, one or more memories 520 coupled to the processor 510, and one or more communication modules 540 coupled to the processor 510.

[120] The communication module 540 is for bidirectional communications. The communication module 540 has one or more communication interfaces to facilitate
5 communication with one or more other modules or devices. The communication interfaces may represent any interface that is necessary for communication with other network elements. In some example embodiments, the communication module 540 may include at least one antenna.

[121] The processor 510 may be of any type suitable to the local technical network and
10 may include one or more of the following: general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on multicore processor architecture, as non-limiting examples. The device 500 may have multiple processors, such as an application specific integrated circuit chip that is slaved in time to a clock which synchronizes the main processor.

[122] The memory 520 may include one or more non-volatile memories and one or more
15 volatile memories. Examples of the non-volatile memories include, but are not limited to, a Read Only Memory (ROM) 524, an electrically programmable read only memory (EPROM), a flash memory, a hard disk, a compact disc (CD), a digital video disk (DVD), an optical disk, a laser disk, and other magnetic storage and/or optical storage. Examples
20 of the volatile memories include, but are not limited to, a random access memory (RAM) 522 and other volatile memories that will not last in the power-down duration.

[123] A computer program 530 includes computer executable instructions that are executed by the associated processor 510. The instructions of the program 530 may include instructions for performing operations/acts of some example embodiments of the
25 present disclosure. The program 530 may be stored in the memory, e.g., the ROM 524. The processor 510 may perform any suitable actions and processing by loading the program 530 into the RAM 522.

[124] The example embodiments of the present disclosure may be implemented by means of the program 530 so that the device 500 may perform any process of the disclosure as
30 discussed with reference to FIG. 2 to FIG. 4. The example embodiments of the present disclosure may also be implemented by hardware or by a combination of software and hardware.

[125] In some example embodiments, the program 530 may be tangibly contained in a computer readable medium which may be included in the device 500 (such as in the memory 520) or other storage devices that are accessible by the device 500. The device 500 may load the program 530 from the computer readable medium to the RAM 522 for execution. In some example embodiments, the computer readable medium may include any types of non-transitory storage medium, such as ROM, EPROM, a flash memory, a hard disk, CD, DVD, and the like. The term “non-transitory,” as used herein, is a limitation of the medium itself (i.e., tangible, not a signal) as opposed to a limitation on data storage persistency (e.g., RAM vs. ROM).

10 [126] FIG. 6 shows an example of the computer readable medium 600 which may be in form of CD, DVD or other optical storage disk. The computer readable medium 600 has the program 530 stored thereon.

[127] Generally, various embodiments of the present disclosure may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. Some aspects may be implemented in hardware, and other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device. Although various aspects of embodiments of the present disclosure are illustrated and described as block diagrams, flowcharts, or using some other pictorial representations, it is to be understood that the block, apparatus, system, technique or method described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

[128] Some example embodiments of the present disclosure also provide at least one computer program product tangibly stored on a computer readable medium, such as a non-transitory computer readable medium. The computer program product includes computer-executable instructions, such as those included in program modules, being executed in a device on a target physical or virtual processor, to carry out any of the methods as described above. Generally, program modules include routines, programs, libraries, objects, classes, components, data structures, or the like that perform particular tasks or implement particular abstract data types. The functionality of the program modules may be combined or split between program modules as desired in various embodiments. Machine-executable instructions for program modules may be executed within a local or

distributed device. In a distributed device, program modules may be located in both local and remote storage media.

[129] Program code for carrying out methods of the present disclosure may be written in any combination of one or more programming languages. The program code may be provided to a processor or controller of a general purpose computer, special purpose computer, or other programmable data processing apparatus, such that the program code, when executed by the processor or controller, cause the functions/operations specified in the flowcharts and/or block diagrams to be implemented. The program code may execute entirely on a machine, partly on the machine, as a stand-alone software package, partly on the machine and partly on a remote machine or entirely on the remote machine or server.

[130] In the context of the present disclosure, the computer program code or related data may be carried by any suitable carrier to enable the device, apparatus or processor to perform various processes and operations as described above. Examples of the carrier include a signal, computer readable medium, and the like.

[131] The computer readable medium may be a computer readable signal medium or a computer readable storage medium. A computer readable medium may include but not limited to an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, or device, or any suitable combination of the foregoing. More specific examples of the computer readable storage medium would include an electrical connection having one or more wires, a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), an optical fiber, a portable compact disc read-only memory (CD-ROM), an optical storage device, a magnetic storage device, or any suitable combination of the foregoing.

[132] Further, although operations are depicted in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Likewise, although several specific implementation details are contained in the above discussions, these should not be construed as limitations on the scope of the present disclosure, but rather as descriptions of features that may be specific to particular embodiments. Unless explicitly stated, certain features that are described in the context

of separate embodiments may also be implemented in combination in a single embodiment. Conversely, unless explicitly stated, various features that are described in the context of a single embodiment may also be implemented in a plurality of embodiments separately or in any suitable sub-combination.

- 5 [133] Although the present disclosure has been described in languages specific to structural features and/or methodological acts, it is to be understood that the present disclosure defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

WHAT IS CLAIMED IS:

1. An apparatus comprising:
at least one processor; and
at least one memory storing instructions that, when executed by the at least one
5 processor, cause the apparatus at least to:
receive a configuration indicating contention free random access (CFRA)
resources for at least one candidate cell;
receive a cell switch command indicating a target cell, the target cell being one
of the at least one candidate cell; and
10 discard the CFRA resources based on a Random Access Channel (RACH)-less
cell switch to the target cell.
2. The apparatus of claim 1, wherein the apparatus is caused to:
determine the target cell based on a target configuration index in the cell switch
15 command.
3. The apparatus of claim 1, wherein the CFRA resources are 4-step Random Access
(RA) resources or 2-step RA resources.
- 20 4. The apparatus of claim 1, wherein the apparatus is caused to:
discard the CFRA resources associated with the target cell, or
discard the CFRA resources associated with all of the at least one candidate cell, or
discard the CFRA resources associated with a set of cells of the at least one candidate
cell.
25
5. The apparatus of claim 1, wherein the apparatus is caused to:
obtain a Timing Advance Command (TAC) from the cell switch command; and
discard the CFRA resources based on the TAC.

6. The apparatus of claim 5, wherein the apparatus is caused to:
in accordance with a determination that a value in the TAC is not set to a predetermined value, discard the CFRA resources.
- 5
7. The apparatus of claim 5, wherein the apparatus is caused to:
in accordance with a determination that a value in the TAC is not set to a predetermined value, measure a value of Timing Advance (TA) for the target cell; and
in accordance with a determination that the value of the TA is successfully measured,
10 discard the CFRA resources.
8. The apparatus of claim 6 or 7, wherein the predetermined value is a hexadecimal value of FFF.
- 15 9. The apparatus of claim 1, wherein the apparatus is caused to:
discard the CFRA resources at a time point that the RACH-less cell switch is completed.
10. The apparatus of claim 9, wherein the apparatus is caused to:
20 discard the CFRA resources at a time point that at least one Radio Resource Control (RRC) message completing the RACH-less cell switch is transmitted.
11. The apparatus of claim 1, wherein the apparatus is caused to:
discard the CFRA resources at a time point that the apparatus performs at least one
25 uplink transmission on the target cell to which the apparatus is switched.
12. The apparatus of any claims 1 to 11, wherein the apparatus is caused to:
receive a further configuration indicating whether the CFRA resources are to be discarded.

13. The apparatus of claim 12, wherein the further configuration further indicates that the CFRA resources are discarded per cell, per set of cells, or for the at least one candidate cell.

5

14. The apparatus of any of claims 1 to 13, wherein the CFRA resources are discarded via a Medium Access Control (MAC) layer or a Radio Resource Control (RRC) layer.

10

15. The apparatus of any of claims 1 to 14, wherein the discarded CFRA resources exclude CFRA resources for beam failure recovery.

16. The apparatus of any of claims 1 to 15, wherein the at least one candidate cell is for a Layer 1 or Layer 2 (L1/L2) triggered mobility (LTM) cell switch.

15

17. The apparatus of any of claims 1 to 16, wherein the RACH-less cell switch is a RACH-less Layer 1 or Layer 2 (L1/L2) triggered mobility (LTM) cell switch.

18. A method comprising:
20 receiving a configuration indicating contention free random access (CFRA) resources for at least one candidate cell;
receiving a cell switch command indicating a target cell, the target cell being one of the at least one candidate cell; and
discarding the CFRA resources based on a Random Access Channel (RACH)-less
25 cell switch to the target cell.

19. An apparatus comprising:
means for receiving a configuration indicating contention free random access (CFRA) resources for at least one candidate cell;

means for receiving a cell switch command indicating a target cell, the target cell being one of the at least one candidate cell; and

means for discarding the CFRA resources based on a Random Access Channel (RACH)-less cell switch to the target cell.

5

20. A computer readable medium comprising instructions stored thereon for causing an apparatus at least to perform the method of claim 18.